IS OUR CLIMATE CHANGING?

By J. B. Kincer, Chief, Division of Climate and Crop Weather, U. S. Weather Bureau. March 10, 1937.

The weather is discussed more frequently than any other topic which affords a subject for convenient conversation. It has been so since the dawn of civilization and doubtless for countless ages before. This is but natural, for the weather is not only our constant companion from the cradle to the grave, but it has a direct bearing on our individual and even national welfare. To many city dwellers it may have but a passing interest, but to the farmer it is of vital concern, for upon the weather depend largely the returns from his labor. Crops are at the mercy of the weather from the time of planting until the harvest. It is the farmers' working partner, so to speak, but this "silent partner" has a moody disposition. Instead of supplying temperatures, sunshine, and rain in the right proportions, it may be damaging storms of wind and hail, untimely frosts, destructive floods, or devastating drought. Agriculture is subject to greater risks than is any other major, legitimate industry of our country, yet it is basic, not only for our national welfare, but for our very existence as a nation.

While crops are subject to loss or destruction from various weather elements, the most important are temperature and rainfall, especially the matter of droughts. Drought has been man's relentless enemy down through the ages. The earliest historical reference to periodic deficiencies in rainfall is found in the Bible, where we are told of years of plenty followed by years of famine. Thus, at the outset, we see that recurring, disastrous droughts are not a product of recent years as some apparently think. They are of especial concern, however, in areas having normally scanty precipitation.

Little is known of the agriculture of prehistoric man, but in that part of the World supposed to have been the cradle of the race, rainfall is insufficient for successful agriculture under natural conditions. However, from the ruins of irrigation canals, to supplement the moisture supplied directly by nature, it appears that the dependence of crops upon rainfall was recognized at the very dawn of history. As early as 3000 B.C., if not earlier, man was a tiller of the soil and garnered a harvest; and from that remote date up to the Eighteenth Century the history of agriculture and the weather is contemporary with that of civilization itself.

Many people think, because of the recent successive drought years, that our climate is permanently changing, either naturally or from some act of man. The popular fallacy that man can basically change climate or that it is changing from some other cause is not a product of the 20th century by any means. It is as old as historical America. In the log of one of Columbus' voyages, the following is found: "JAMAICA, July 18, 1494, *** In the western part of Jamaica there gathered every evening a storm of rain, which lasted about an hour, more or less, which the Admiral (Columbus) said he attributed to the great woods in those countries, for that he knew was usual, at first in the Canary Islands, and the Azores, whereas now the woods are cut down that shaded them, there are not such great and frequent storms of rain as there were formerly." In Volney's "Climate of the United States of America", London, 1804, Thomas Jefferson's weather diary is quoted as

follows: "A change in our climate is taking place very surely. Both heat and cold are becoming more moderate within the memory of even the middle-aged, and snows are less frequent and less deep." Volney says that Jefferson's conclusion on this matter as to a marked change in climate was verified also by older residents with whom he discussed the matter in Kentucky, Ohio, Pennsylvania, New York and New England. Yet the records Volney gives as to average rainfall are about the same, in general, as those of recent years, more than a century and a quarter later. These impressions evidently were occasioned by the now well-known comparatively long-time trends in climate.

This brings us to the question, "Is Our Climate Changing?" The answer depends on just what is meant by a change in climate, whether a temporary change or a permanent change. For a good many years up through 1936 there has been a decided tendency to warmer and drier weather, the trends being especially marked during the past quarter of a century, notwithstanding an occasional bad flood or severely cold winter. Take the winter season for example: With the exception of that for 1917-18 and 1935-36, the winters for the past 25 years or more, considering the country as a whole, have been rather uniformly warmer than normal. Also, in the matter of rainfall, there has been an equally marked tendency to droughts in recent years. However, an examination of the longer weather records of the country, going back 100 years or more, indicates that this does not represent a permanent change of climate, but rather a warm, dry phase of our normal climate, to be followed, doubtless, by a cooler, wetter phase, when there will be more rain in summer and lower temperatures in winter.

Let us explain it this way: We have weather and we have climate. Weather refers to conditions for a day, a week, or even a year. We say, for example, that the weather last month was so and so. Climate is the average weather (temperature, rainfall, etc.) over a very long period of years, for the purpose of comparison, say, 100 years. Now we know that our weather from day to day and week to week frequently goes in a more or less cyclic movement, something like the waves of the ocean. That is, a few cool or cold days are succeeded by several days of warmer weather, and frequently a few days of rain are followed by fair, sunny weather for a short period. Now the same thing happens in climates, the only difference being that we count the time in periods of years instead of days. It is important to remember that these climatic cycles vary in length, just as do the weather cycles, resulting in some periods of light rainfall, or droughts, lasting longer than others.

Droughts in the United States may be divided into two general classes. In one class are those of a transitory nature, affecting usually a relatively small area and of comparatively short duration, frequently lasting only a single year; in the other are those general droughty conditions that have a tendency to persist for comparatively long periods of time. When a minimum phase of precipitation obtains, such as recently experienced, there occur at short intervals what may be called families of droughts, in contradistinction to the transitory, or short period, ones that fall in the first group. Short-period droughts, in general, are characteristic of sections having comparatively heavy rainfall, such as east of the Mississippi River, and long-period droughts in areas of relatively light rainfall, such as the western Great Plains.

Prior to the minimum phase of precipitation responsible for the recent family of droughts, so to speak, the last general condition of this kind occurred in the latter part of the 80's and the early 90's of the last century. At that time, following a series of years with rather abundant rainfall, widespread deficiencies in moisture began in 1886 extending up to 1895, culminating in severe droughts in 1894 and 1895, the driest years of that minimum phase. Following this there was a series of years with rainfall ranging generally above normal.

In the period between the 1886-95 extensive drought and that beginning about 1930, there were several belonging to the transitory class -- (short-lived and often affecting seriously only comparatively small areas). Among these may be mentioned that of 1901 in the interior valleys and the Southwest. The following year, 1902, had plenty of moisture in most States. Another transitory drought occurred in 1910, principally in the Central and Northern States and the South, but this again was largely a one-year affair. Another one in 1917 affected mostly the Southwest and northern Plains, and still another, in 1925, was severe in the South and Southeast. Thus, for some 60 years up to 1930, there were a number of short-period droughts, but only one persistent and markedly dry phase of United States climate, that of 1886-1895, lasting, in general, about 10 years. Some years, of course, were better than others.

The more recent dry phase begain in 1930 and continued, with a few interspersions of fairly good years, such as 1935, up through the summer of 1936. There have been in this period three extremely dry years -- 1930, 1934, and 1936.

The few available precipitation records, covering 100 years or more, indicate that a general dry phase, somewhat comparable to that of 1886-95, and the more recent one of 1930 to date, obtained in the 30's of the last century, or approximately 100 years ago.

The outstanding wet phase of the United States climate in the last century was from about 1865 to 1885, with a secondary maximum during the first two decades of the present century, though several transitory droughts were interspersed. This summary refers specifically to that part of the country east of the Rocky Mountains.

Some tree-ring records of the far Northwest indicate that there probably was a major minimum precipitation phase, at least in that area, soon after the middle of the 18th century, within the period 1755-80, with a succeeding maximum phase culminating about the beginning of the 19th century.

While study of long weather records has not as yet disclosed a law to justify a forecast of future droughts, such study does give an historical background, which warns us that droughts in the future may be expected, just as severe as those of the past. For example, the records show that in the early nineties, or some 40 years ago, there was a drought in the so-called "dust bowl" of the Great Plains about as severe as that recently experienced. Doubtless, when the present drought definitely comes to an end, there will be a period of years with comparatively heavy rainfall, just as before, and little will be heard about duststorms and the like. But, in

planning a permanent farm program for such areas, the basic considerations should include the practical certainty that dry climatic phases, at least as severe as in the past, will recur.

There is much loose talk these days about changes in climate due to human activity, and various suggestions that man should do this, that, or the other thing to prevent droughts. Such talk is utter nonsense. But here we must distinguish between preventing droughts as such and doing certain things to modify the unfavorable conditions when the droughts do occur. These two things are separate and non-related.

Many theories are advanced as to the cause of the recent droughts. Those most frequently heard are extensive radio broadcasting and the drainage of small lakes, ponds, marshes, and the like. Most of the others are too silly even to mention.

The broadcasting theory may be disposed of quickly. It is definitely known that radio waves have no influence whatever on atmospheric pressure conditions nor on the temperature. Consequently, they could not affect condensation, the major factor in precipitation. Furthermore, some long records show that quite similar, or even more severe, droughts occurred many years before the radio was even thought of. If broadcasting is responsible for recent conditions, what was the sinister influence that caused the drought centering around 1850 and that in the early nineties of the last century?

The drainage theory, sponsored by a good many thinking people, requires more deliberate consideration; on its face it appears logical and convincing. It is argued that, with the destruction of thousands of square miles of water surface, there is obviously less moisture contributed to the atmosphere through evaporation, and, consequently, less to condense and precipitate as rain. This also is superficial reasoning.

Two fundamentals are necessary to produce rain; first, water must be gotten into the air through evaporation from moist surfaces and transpiration through the leaves of growing plants; and, second, the invisible water vapor thus supplied must be condensed into liquid form as rain drops. The drainage theory as a cause of the drought overestimates the importance of the first phase of the problem. Many seem to think that all that is necessary to produce rain is to supply the air, or more correctly speaking, space, with sufficient moisture. However, the second phase is by far the more important. In other words, there is nearly always enough moisture present in the air to produce rain in substantial amounts whenever the machinery of nature's rain factory is operating in a manner to cause sufficient condensation.

There is abundant evidence to substantiate this statement. For example, in parts of southwest Africa, even in coastal sections, the average rainfall is less than one inch a year, yet the adjoining Atlantic Ocean is one of the largest bodies of water in the world, affording abundant opportunity for an ample supply of atmospheric moisture. In southern California in July there is as much moisture in the air as in central New England, yet rain rarely occurs in California during this month, but usually is comparatively abundant in New England, being on the average more than a hundred

times greater than in southern California. Minnesota is dotted with small lakes, yet Iowa, hard by, with very few lakes, has, on the average, 25 percent more rainfall in a year than has Minnesota. Also, it may be pointed out that recent downward trends in the rainfall curve have been greater in Minnesota (the premier lake State) than in any other State. Again, Michigan is nearly surrounded by large bodies of water, while Indiana, adjoining, with less than one-half of one percent of the total surface water, has an average of 30 percent more rainfall.

Let us cite an even more striking example showing that rainfall depends upon air mass movements to a much greater extent than upon local influences or the amount of moisture that happens to be in the atmosphere at the time. Keokuk, Iowa, for the entire month of July, 1936, had only 0.01 inch of rainfall, while for the following September there were 7.59 inches. Weather Bureau records show that at Keokuk there was actually more moisture in the atmosphere during July than in September.

In the Ohio Valley, where severe drought recently prevailed, January 1937 brought unprecedented rainfall, and one of the greatest flood disasters of history. What act of man brought this reversal of conditions since last summer? When we think these things through, on a background of facts, suggestions of man-made changes in climate are relegated to the kindergarten of science.

Rather than being a man-produced affair, recent mid-West conditions are only what may reasonably be expected from time to time under our prevailing climate. While climatologists have as yet been unable to foretell the exact time of occurrence of these periodic rainfall depressions, the droughts, with all their dire consequences, have been no surprise to them. For example, during the first two decades of the present century rainfall in the Great Plains was unusually abundant. This produced optimism and encouraged an unfortunate extension of cultivation farther and farther into regions which never should have known the plow. The danger was foreseen by Weather Bureau officials at the time and a warning note sounded. The following quotation is from a paper by the late J. Warren Smith, presented before a joint meeting of the American Meteorological Society and the Association of American Geographers at St. Louis, Mo., December 31, 1919, and subsequently published in the Monthly Weather Review: "Years of abundant and well-distributed rainfall encourage a western extension of the cultivated area, and when there is a succession of favorable years farm operations may be pushed so far into the semiarid districts that in the succeeding drier years the rainfall is entirely insufficient for crop needs, and disaster results." This was written at a time when optimism was running high because of the favorable situation in the Great Plains during the years immediately preceding.

We have said that recent droughts in the Midwest are only what may be expected to occur periodically in climates such as this, and future years will doubtless see repetitions. However, there is no evidence that during the last few years the climate has permanently changed to an appreciable extent, but rather we are going through a periodic dry phase of the existing climate.

Rainfall trends such as we have described, and consequent occasional periods of disastrous drought, are not confined to our own Midwest, but they obtain also in other parts of the World having similar climates. It is interesting to compare the records for Warsaw, Poland, having rainfall conditions comparable to Minnesota, and for which records are available for more than 100 years, with data for St. Paul, Minn., where a century of record is also available. These show very similar conditions as to characteristic trends, and periodic deficiencies, though the time phases, of course, do not coincide. On the basis of a 5-year accumulated departure from normal, we find in the case of Warsaw for the 5 years ending with 1826 a deficiency of 23.9 inches; 1896, 20.3 inches, and 1924, 18.9 inches. These compare favorably with similar data for St. Paul for the 5 years ending with 1856 showing a deficiency of 25.9 inches; 1891, 21.6 inches, and 1936, 22.1 inches. Thus in far away Poland the weather behaves much the same as in our own Minnesota, and yet some would have us believe that man there has thrown a monkey wrench into the machinery of nature's world-wide laboratory.

In discussing drought we speak glibly of certain deficiencies in rainfall, with reference to the normal, but seldom do we grasp the enormous quantities of water represented in such shortages, which should be a matter for study to all who contend that man can make it rain, or who advocate certain practices, such as constructing ponds, to change natural climatic conditions. One inch of rainfall represents for an acre of land 113 tons of water. Last year North Dakota had only about half of normal rainfall. That means that the State, based on the normal rainfall, was short of moisture some 960 tons of water for each acre of land, on the average, or about 43 billion tons for the State. Well, to say it that way doesn't mean much, for it simply doesn't register. Let's put it another way. If it were humanly possible to count these 43 billion tons at a uniform rate of 3 a second, 24 hours a day, and 365 days every year, it would require 450 years to complete the count. When we consider the enormous energy that is required to extract that much additional water from the air for a single State for one year, it is difficult to understand how anyone could seriously consider the proposition of man-made changes in climate.

While duststorms in the Plains are due primarily to droughty conditions, and they are of little concern during the relatively wet phases of climate, it is a tragic fact that the drier sections of the Plains have been extensively plowed and cultivated where crop farming never should have been attempted. Man is not responsible for drought, or dust, as sent by Nature, but he has made the results of drought more devastating to human homes and fortunes by removing from areas not climatically suited for permanent cultivation, the vegetative protection, or covering, that Nature provided. Much of this one-time grassland is now under cultivation and has become an aggravator of duststorms. The basic remedy, of course, is rain. Man cannot make it rain, but he can do the next best thing -- restore the original natural conditions as far as possible, and avoid repeating mistakes of the past.

However, we should not get the idea that Midwest duststorms are something entirely new and of only recent occurrence, unheard of before.

While we have encouraged them in recent years by unwise agricultural practices, they always have been bad in the drier sections whenever extensive droughty conditions obtained. The following are official weather reports from Dodge City, Kansas, not last spring, nor last year, nor the year before that, but nearly a half century ago, and they have remarkable conformity to similar reports of recent years:

April 8, 1890: At 10 a.m. the dust in the air was so dense that objects could not be distinguished 100 yards off. No one who could possibly remain indoors was on the street.

August 13, 1892: The wind raised such a cloud of dust that it was impossible to see over 150 feet ahead.

April 6, 1893: The dust was blinding and was deposited so thickly on office furniture that everything looked as though it were covered by a layer of dirt prepared for a hot-bed.